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LNBUG # 2
65ØØ DEVELOPMENT MONITOR

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TABLE OF CONTENTS

LNBUG 65ØØ DEVELOPMENT MONITOR

INTRODUCTION: The MCS65ØØ Development Monitor is a comprehensive debug package including complete list and modify commands, mini-assembler/disassembler, disc and tape communications, stepping, trace, and breakpoint capabilities, and other useful memory manipulation commands. The program is designed to run on an S-1ØØ type computer utilizing an Atari trace memory interface board with a video or hard copy terminal.

To run the monitor, the system must be configured as follows:

1 - Atari GVA-2503 CPU card
1 - Dynabyte 16K RAM card
1 - Cromemco 16K ROM card
1 - Atari GVA-25Ø4 Trace Memory Interface Card

Make sure to set switches as specified on sheet labeled "DEVELOPMENT SYSTEM SWITCHES." A copy of this is included at the back of this manual.

With the BOOTSTRAP switch on, the monitor will be entered upon reset, starting at location 6ØØØ.

If reset is desired to clear vectors and reset all monitor cells, a carriage return should be the first character entered. If a "warm" reset is desired, hit any other key. The monitor will echo

"NOW ENTERING LNBUG #X"

to indicate the entry to the monitor and the version being used.

After a "cold" reset, the user must select the control set for the terminal being used:

Type "D" <CR> for a Digilog terminal.
Type "H" <CR> for a hard copy terminal.
For Lear Siegler, type nothing.

The monitor is now ready for operation.

BASIC COMMAND FORMAT:

Commands to the monitor are entered in a line at a time in the deferred mode or with a single keystroke in the immediate mode.

The command and the optional suffix are always entered in after necessary address and data entries.

Examples:

Format	Example
Command Suffix	DX
Adr Command Suffix	1ØØØ/Q
Adr1.Adr2 Command Suffix	1ØØØ.11ØØ/Q
Adr1.Adr2, Data Command	1ØØØ.11ØØ,ØØ#
Adr1.Adr2, Adr3 Command	1ØØØ.11ØØ,1ØØ3M

"Adr1.Adr2" indicates start and stop addresses. "Adr3" indicates destination address, "Suffix" is always optional. "Deferred" commands are line oriented and all key entries are stored in a buffer until <CR> is hit. The buffer can be modified prior to execution using various key buffer operators.

COMMAND DESCRIPTIONS:

The following descriptions are organized into the following groups:

List and Modify Memory
Macro Memory Operators (Move, Verify, etc.)
Patching Command
Program Loading and Saving
Key Buffer Operators
Functions for Running Programs
Suffixes
Relocation Register
Terminal Control

In the following descriptions, Mode "D" is the deferred mode and "I" is the immediate mode. (See descriptions above.) All values are in hexidecimal.

LIST AND MODIFY:

Command	Mode	Description
R	I	Display user CPU registers.

EX: User types- R

Monitor prints:

PC=2ØØØ P=ØØ A=Ø1 X=FF Y=FF S=EA

/	D	List memory from start to stop address. Or, if start address only is specified, all locations up to the next address increment of sixteen will be listed.

EX: User types- 1ØØØ.1ØØ8/ (echoed)

Monitor prints after return:

```
      Ø  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
1ØØØ = AA ØØ A9 11 Ø1 FF 21 BC C9
```

EX2: User types- 1ØØA/ (echoed)

Monitor prints after return:

```
      Ø  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
1ØØA =                              B9 Ø1 21 C9 ØØ DØ
```

EX3: User types- 2ØØØ.2ØØ6/Q (echoed)

Monitor prints after return:

```
2ØØØ  LDA I,ØFF
2ØØ2  STA Z,1Ø
2ØØ4  DEX
2ØØ5  BNE 2Ø28
```

/	I	When no address is specified, list the next sixteen locations starting from the last list address plus one. Allows convenient continuous listing.

EX: User types- / (not echoed)

Monitor prints:

1Ø1Ø = AA 99 24 32 7D A9 CØ ØD (etc.)

LIST AND MODIFY (continued)

Command	Mode	Description
SHFT /	I	List one location.

EX: 1ØØØ/ (echoed)

Monitor reprints line on shift /:

1ØØØ = A9

A repeat of just the shift / prints:

1ØØØ = A9 again

(This is useful for reading PIA ports)

:	D	Modify memory. Opens memory for modification starting at specified address. Memory is not actually modified until carriage return is hit or until address passes over an increment of sixteen. (Automatic carriage return for continuous entry.) All key buffer operators can be used. (Rub, escape, etc.)

EX1: User types- 1ØØØ: (echoed)

Monitor prints:

```
        Ø  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
1ØØØ =
```

The cursor is then positioned under "Ø" waiting for a user entry.

EX2: User types- 1ØØØ: (echoed)

Monitor prints:

1ØØØ:Q

The monitor is now waiting for the user to enter in mnemonics.

Command	Mode	Description
:	I	Modify memory starting at start of prior listing. Or, modify user CPU registers if "R" command preceded ":" command. All other characteristics are identical to ":" in the deferred mode.

EX: User types- 1ØØØ/

Monitor prints locations 1ØØØ-1ØØF as shown above. User then types / (not echoed)

Monitor prints:

1ØØØ:

The monitor is now waiting for user entry.

SHFT:	I	Modify one location. Immediate modification of one location.

EX: User types- SHFT:

Monitor prints:

1ØØØ:

Only this one location will be modified and address location pointer is not incremented.

K	D	Macro Listing Command. A macro listing command used during trace or under user control. Up to six single locations or lists (of any length) can be specified and then listed either during breakpoint/step operation or when "K <CR> " is specified. To set these, specify: Adr1.Adr2 - List, Adr1 - Single location. Separate with commas, and end line with "K <CR> ." Any number of entries (up to six) are allowable and can be in any order. The "X" suffix clears the "K" directory.

EX: User types- ØØ.ØF,4Ø94,4Ø21K

When a breakpoint occurs in a user program, or if the user types in "K <CR> ", the monitor will print:

```
      1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
ØØØØ = AA 1Ø ØØ ØØ FF ØØ 1Ø Ø1 11 AC C9 FØ DØ ØØ ØØ
4Ø94 = 21
4Ø21 = A2
```

Note that if trace mode is set, the listing will be made after every breakpoint, whereas, if the trace mode is not set, the listing will be made after passing through the breakpoints "N" times as set by the "N" command.

MACRO MEMORY OPERATORS

Command	Mode	Description
M	D	Move memory from start address to stop address to destination address. Accounts for direction of move to prevent memory destruction in overlapping moves.

EX: User types- 1ØØØ.1ØFF,1ØØ3M

Monitor then moves block up three bytes.

!	D	Program 27Ø8 EPROM's using Byte-Saver board. Specify source start and stop addresses and destination address (Byte-Saver address). Any number of bytes can be programmed at a time without timing problems as the program always maintains at least a "1K Duty Cycle" to prevent damage to the PROM.

EX: User types- 1ØØØ.13FF,8ØØØ!

Programs RAM area 1ØØØ to 13FF to the PROM located at 8ØØØ.

Monitor then prints:

PROM AREA O.K.
IS PROGRAMMER UNPROTECTED & READY?

The user then types either "Y" for yes or "N" for no. Yes starts the programmer, no returns control to the monitor.

=	D	Compare memory. Compare one block of memory with another. Specify start and stop addresses of one block and start address of block to be checked (Adr3).

For example, see move instruction and verify instruction.

V	D	Verify proper memory operation by writing "55" and "AA" to locations, while saving current contents for non-destructive checking. Specify start and stop addresses.

EX: User types- 2ØØØ.3ØØØV

Monitor prints:

First error 24ØØ
Total errors = 1Ø24

MACRO MEMORY OPERATORS (continued)

Command	Mode	Description
#	D	Fill memory with specified data byte, starting at Adr1 and ending at Adr2. EX: 1ØØØ.1FFF,ØØ# will set locations 1ØØØ to 1FFF with "ØØ."
Z	D	Delete all memory.

PATCHING COMMAND

Command	Mode	Description
I	D	Insert patch in program. Allows user to specify an address in the program under development and insert instructions at this address without affecting the rest of the program. The monitor actually places the patched code in a "Patch Area" and inserts a "BRK" at the user program address upon starting the program.. Utilizing a "Patch Directory," the monitor is able to vector the user program to the proper patch in the patch area upon encountering a "BRK." The patch has already been constructed automatically to jump back to the user program.

EX:

```
          User Program
1ØØØ  LDA I,ØØ
1ØØ2  STA ZX,Ø3
1ØØ4  DEX
1ØØ5  BNE 1ØØØ

Insert "DEY" at 1ØØ2.
Patch area:
4ØA6  DEY
4ØA7  STA ZX,Ø3  Added automatically
4ØA9  JMP 1ØØ4   by patch program

Or, insert "BPL 1Ø1Ø" at 1ØØ5
Patch area:
4ØC6  BMI 4ØCB
4ØC8  JMP 1Ø1Ø   This structure automatically
4ØCB  BEQ 4ØDØ   constructed by patch program
4ØCD  JMP 1ØØØ
4ØDØ  JMP 1ØØ7
```

Note that upon return to monitor, all "BRK" instructions are replaced with the original instruction making the patch transparent upon listing.

Eight blocks of 32 bytes each are maintained in the patch area. Thus, a maximum of eight patches can be made. If a patch consumes more than 32 bytes, it will automatically link itself to the next patch area block provided the block is free.

A patch is specified by entering in the address, the desired patch number (optional - automatically finds available patch), the "I" command, and a carriage return. The desired instructions are then entered in mnemonics a line at a time. Two carriage returns in a row will terminate the patch.

PATCHING COMMAND (continued)

Command	Mode	Description
		The patch is effectively placed just prior to the address specified. Note that this type of patch consumes an average of 100-200 processor cycles and should not be used in time critical operations.
IX	D	"AdrIX" deletes that patch. "Ø,Patch#IX" also deletes one patch. EX: Ø,4IX deletes patch #4 "IX" deletes all patches

LISTING & SAVING PATCHES

"I" lists patch directory for reference use.

To save patches and breakpoints, write locations 8Ø64-81A5 to the disk or tape. Note that this will also store the user's zero page locations ØØ-Ø3, the trace mode, relocation register, and step counter. DO NOT RECORD this section while in step mode. Always load this section before setting step mode.

PATCH & BRKPNT WARNING: If a location that is a patch is modified, that patch will be deleted from the patch directory. But, if the location is changed to a ØØ, the old patch code will be replaced and the patch maintained, even though the program will not run correctly. Care should be taken when modifying patched code. References to patches here also apply to breakpoints.

PROGRAM LOADING/SAVING

Command	Mode	Description
L	D	Loads data from terminal in the standard MOS Technology LOAD format. Returns control to monitor upon receipt of an ASCII DC3 (Control X-Off). No address is specified. Note that tapes made with this monitor contain the "L," <CR> and DC3, so loading is done by simply turning on the tape. Echoes on terminal if trace mode is set.
W	D	Write hex to terminal in standard MOS Technology format. Specify start and stop addresses in the usual fashion. Note that an "L," <CR> and DC3 are transmitted at the proper times to allow simple reloading.

KEY BUFFER OPERATORS

RUB	I	Delete Last Entry. Rubout - erase last entry. On Lear Siegler, underscore is equivalent; i.e., shift is not required.
Line Feed	I	Non-Destructive Advance. Advance one address or one instruction (in mnemonics mode) if first entry of line, or one character in any other mode. Does not affect contents of buffer or memory. This should be used only to skip a previous entry. Space should be used initially if skips are desired.
Space	I	Delete Current Entry and Advance. Erase previous key entry and advance one address if modifying memory in hex mode. Otherwise, print non-functioning space character.
Backspace (Control H)	I	Back Up One Address.
Escape	I	Delete and Escape Current Line.
CR	I	Execute Current Line.

FUNCTIONS FOR RUNNING PROGRAMS

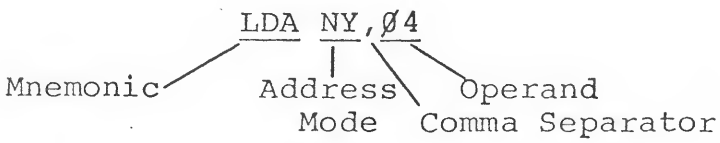
Command	Mode	Description
G	D	Go From Start of Program. "GO" starting either at specified address or at address specified in previous GO command if no address is specified, (for restarting program). EX: First Pass: 1ØØØG Starts program at 1ØØØ. Thereafter, typing only a "G <CR> " will start program at 1ØØØ.
P	I	Proceed From Current Program Address. (Proceed from BREAKPOINT, SINGLE STEP, Control C, etc.)
S	D	Set single step mode (Use SX to reset to continuous mode.)
T	D	Set trace mode (use TX to reset). Lists breakpoint #, CPU registers, next instructions, and any memory locations as specified in K command upon breakpoints or single step. Also used to specify an echo upon loading programs via the terminal. (See "L" command.)
N	D	Set Number of Steps or Breakpoints. Set number of times through breakpoints or single step before tracing and returning to monitor. Specify any hex number up to "FF." Note that "ØN" will run continuously. Specifying just N with no number defaults to Ø1. EX: "1ØN <CR> " will cause 16 breakpoints or steps to run before stopping.
B	D	Set Breakpoints, List Breakpoints. Specify as: ADR,#B where # is the breakpoint number (1-8). Specifying Ø,#BX will delete that breakpoint. BX deletes all breakpoints. "B" only lists breakpoint directory. EX: User types- 1ØØ4,3B Run Program (trace mode set, N=Ø2). Monitor prints: #3 PC=1ØØ4 A=Ø1 X=FF Y=ØØ S=FA BNE 1ØØØ #3 PC=1ØØ4 A=Ø1 Y=FE Y=ØØ S=FA BNE 1ØØØ CAUTION: See warning in "I" instruction about modifying location specified as a breakpoint or patch.

APPENDIX

ASSEMBLER/DISASSEMBLER FORMAT

The format for the assembler is identical to that of the Atari MAC65 format (excluding symbols). This assembler is a 65ØØ adaptation of the RT-11 MACRO, written by Dave Sheppard of Coin-Op Engineering.

EX:



Note that the development assembler does not recognize symbols and all operands must be in hexidecimal. The "Y" relocation suffix can always be specified. Branch instruction operands are specified as the absolute (or relocatable "Y") address. The offset address is then calculated from this address.

If an error is detected, the assembler prints the error message and then returns the cursor to the beginning of the line for re-entry of that line.

To terminate assembly, hit carriage return without entering any other keys (blank line).

Address Mode Specification -

(none)	-	Relative, Implied, Accumulator, or Absolute (Default).
I	-	Immediate
A	-	Absolute
Z	-	Zero Page
NX	-	(Indirect,X)
NY	-	(Indirect),Y
ZX	-	Zero Page,X
AX	-	Absolute,X
AY	-	Absolute,Y
N	-	Indirect
ZY	-	Zero Page,Y

DEVELOPMENT SYSTEM ADDRESS SPACE

Processor:

MAP-Ø (JLT/PRM)

Ø-Ø3FF	Onboard RAM Ø
4ØØ	Control Reg
4Ø1-1FFF	System RAM
2ØØØ-2FFF	System Ram Expansion*
3ØØØ-33FF	Onboard RAM 1
34ØØ-3FFF	System RAM Expansion*
4ØØØ-47FF	Onboard ROM (duplicate)
48ØØ-4BFF	Spare
4CØØ-4FFF	TMI I/O **
	(Bus disconnect only)
4CØØ	Terminal Serial I/O
4DØØ	PIA - 652Ø
4D8Ø	PIA - 6532
4EØØ	Terminal Control Latch
5ØØØ-D5FF	Spare
D6ØØ-D6FF	S1ØØ I/O
D7ØØ-D7FF	Serial I/O
D7ØØ	Terminal 685Ø } Not available with
D7Ø8	PDP 11 685Ø } buss disconnected
D8ØØ-DEFF	Spare
DDXX	Control Reg
DEØØ-EBFF	Spare
ECØØ-FBFF	ROM Expansion
FCØØ-FFFF	Onboard ROM (duplicate)

MAP-1 (DEV-COLEEN)

Ø-1FFF	System RAM
2ØØØ-5FFF*	System RAM Expansion
4CØØ-4FFF**	Trace Memory Interface
	(Bus disconnect only) } Not used
4CØØ	Terminal Serial I/O } with
4DØØ	PIA - 6532 } Coleen
4D8Ø	PIA - 6520
4EØØ	Terminal Control Latch
6ØØØ-7FFF	LNBUG Monitor ROM
7FXX	Monitor Control Reg. (Write Only)
8ØØØ-81FF	Reserved Monitor RAM
82ØØ-87FF	Onboard User RAM
88ØØ-8BFF	Onboard User ROM
8CØØ-8FFF	Spare
9ØØØ-CFFF	Coleen Cartridge and O.S. Ext.*
	16K RAM card or ½ 16K RAM and 8K Byte Saver
DØØØ-D3FF	TIA
D4ØØ-D5FF	Antic
D6ØØ-D6FF	S1ØØ I/O ***
D7ØØ-D7FF	Monitor Serial I/O
D7Ø8	Terminal 685Ø
D71Ø	PDP11 685Ø
D8ØØ-DBFF	Pokey
DCØØ-DDFF	Candy/Coleen PIA
DEØØ-DFFF	Spare
EØØØ-FFFF	System RAM/Coleen O.S.
FFF8-FFF9	User Hardware IRQ Vector
FFFA-FFFB	User NMI Vector
FFFC-FFFD	Reset Vector (with bootstrap off)
FFFE-FFFF	IRQ Vector
	Note that the IRQ vector should be left as is for proper breakpoint & patch operati

* System RAM expansion requires a 2nd 16K RAM board
System ROM expansion requires a Byte Saver

** TMI resources available when processor is used in stand-alone mode.

*** Optional TUART at D6ØØ & D65Ø

DEVELOPMENT SYSTEM SWITCHES

Z-2 BOX - RESET: POC to complete system.

TMI- TERM. Set baud to monitor terminal. Set one (1) switch only for desired rate.

PDP-11 Set baud rate for 2nd serial channel.
A15-8 Address decode of 2 serial channels.
COLEEN Set for D7 negative logic- $\overline{A15}$ $\overline{A14}$ A13 $\overline{A12}$ A11 $\overline{A10}$ $\overline{A9}$ $\overline{A8}$

PROCESSOR

RESET Local reset to processor and associated TMI.
1 MHZ Selects processor clock.
2 MHZ Use only one switch at a time. (ON=SELECT)
EXT.CLK.
JOLT/PROM Selects one of two address decode maps- (ON=JOLT, OFF=LNBUG)
BOOTSTRAP Enables power-on remapping of 7FFF to FFFF. (force A15 low on reset if switch is on)
Bus DISC. Enables processor to system buss vs. stand alone (ON=normal, OFF=disconnect).
W.D. DISABLE Kills a .1 μs hardware watchdog reset. (ON=DISABLE WATCHDOG)

COLEEN PROC. W.D., BUS DISC, BOOTSTRAP, $\overline{JLT}$, EXT. CLK., $\overline{2}$, $\overline{1}$.
TRACE MEMORY W.D., BUS DISC, BOOTSTRAP, JLT, $\overline{EXT.\ CLK.}$, $\overline{2}$, 1.

16K SYSTEM:

DYNABYTE RAM

BANK SELECT	1-8 open: 9 on
WRT PROT	1-5 open
BANK 3&4	1-4,6-8 open: 5, on (EØ-FF)
BANK 1&2	1 open: 2-8, on (ØØ-1F)

32K SYSTEM:

DYNABYTE:

Set as above except:

BANK 1&2 1,4,8 open 2-3, 5-7 on (8Ø-9F)

IMS RAM 32K systems only

J2		uWR
Mem addr		Ø (ØØ-3F)
J1		on,sp
J4		8,4,2,1
J5		2, sp
Addr:	7-6	3
	5-4	3
	3-2	3
	1-Ø	none

DEVELOPMENT SYSTEM SWITCHES (continued)

DRC PROM CARD

D9-D16	n.c.
D1-D8	diodes
WAIT	1-14 jumpered
Select	2-7,3-6 jumpered

16K PROM CARD (Cromemco)

Bank Ø-7 off
OUT off
A15 off
DMA off
A14 on
Disable ROM's Ø-7
Wait Disable

TUART optional

1,3-6,8,10	ON
2,7,9	OFF

BYTESAVER optional

A15-Hi A14-Lo A13-Hi AØ-BF
Wait N.C.
Protect - Off when programming

TERMINAL FORMAT

The 685Ø serial communications ports are configured by software upon reset as follows:

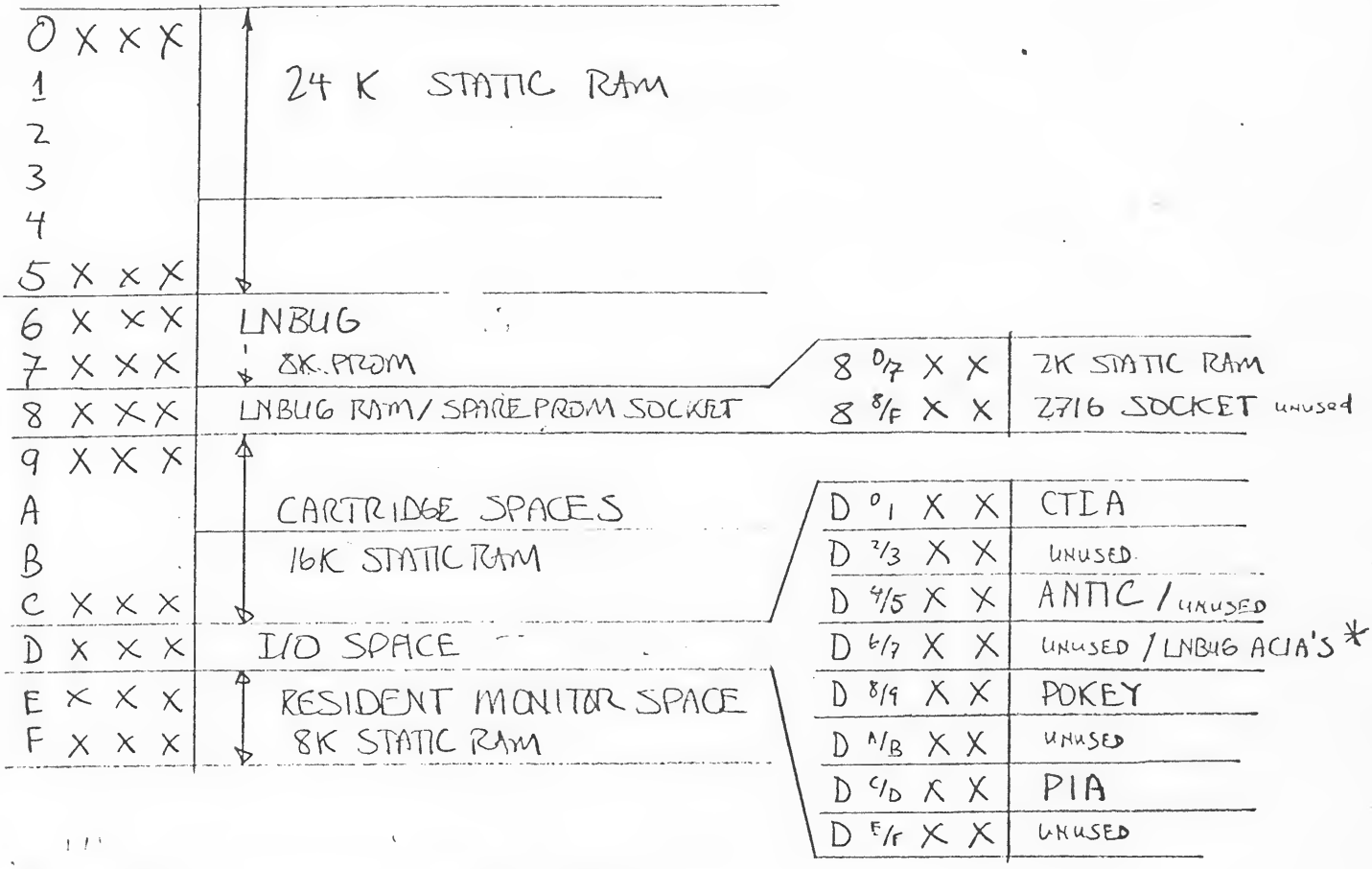
7 Data bits
1 Stop bit
Even Parity

Baud rate is set by switches on the trace memory interface card. Recommended speed when used with TRACE MEMORY, 19,200 baud.

DECLIR 10AUG81ST

COLLEEN / CANDY

DEVELOPMENT SYSTEM ADDRESS MAP



* ACIA'S. PRIMARY PORT D700
PDP-11 PORT D710